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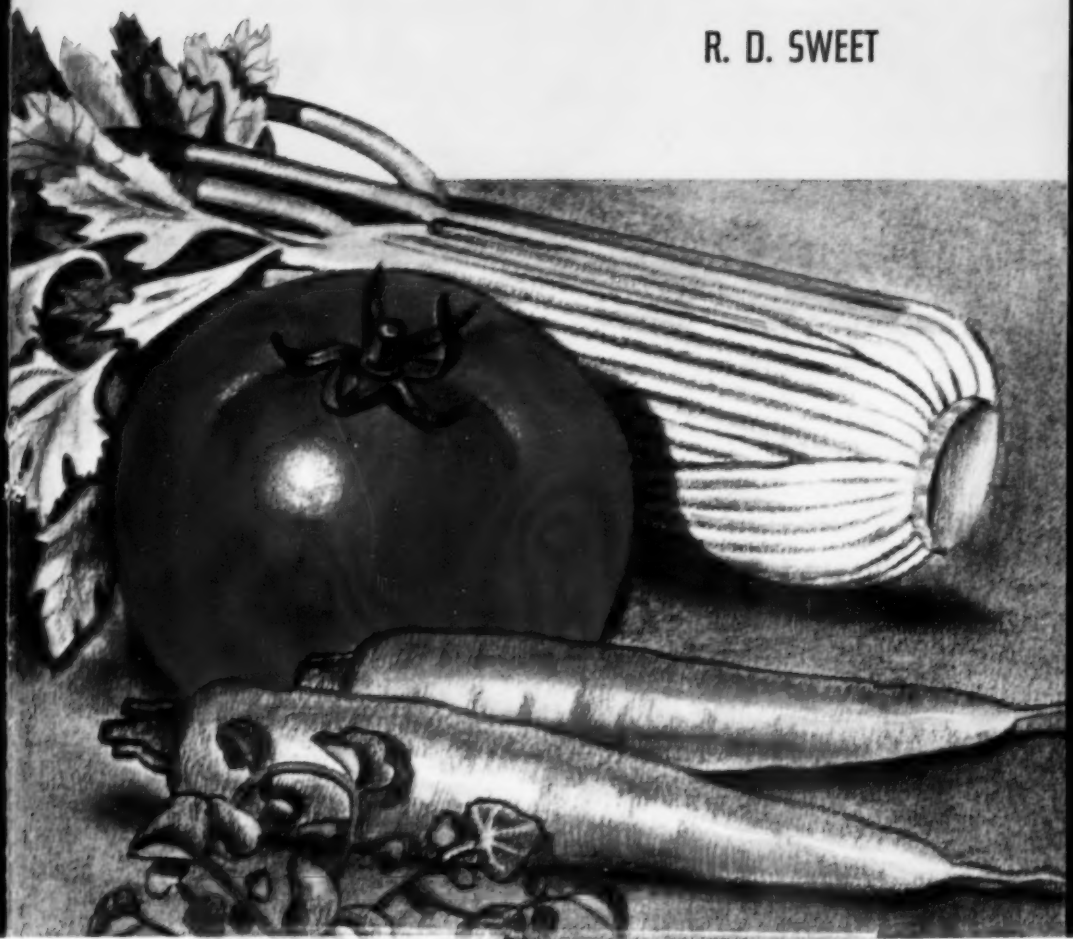
chemical weeding of vegetables

R. D. SWEET



A weed-free bed like this is possible with CMU.

Chemicals made the difference.

This asparagus bed was cultivated in the usual manner.

Contents

Chemical Weeding of Vegetables

BY R. D. SWEET

WEEDS are thieves. They steal food and water from crops and take dollars out of farmers' pockets because they not only reduce yields but also increase production and harvesting costs. It is always expensive to control weeds. Costs are particularly high in the vegetable crops where hand weeding is necessary. Chemicals not only help eliminate the need for extensive hand weeding but also reduce the need for mechanical cultivation. Even with chemicals, however, one or two cultivations and some hand weeding may be necessary.

There is much yet to be learned about controlling weeds with chemicals. For some crops there is no safe and effective chemical available. For most vegetables grown in New York, however, there are chemicals available that will eliminate the need for extensive hand weeding. The methods listed on the following pages are considered the most promising.

General Precautions

Do not expect to solve all weed problems by using chemicals. Regard them as new tools to supplement cultivation.

Be sure to use the right chemical for the right crop.

Know how much material to actually apply. A few ounces too much may readily injure the crop; a few ounces too little will give poor weed control.

Rates are calculated on the basis of the active ingredient. No formulations are 100% active. Read the label carefully to determine the number of pounds of active herbicide in the package.

All recommended rates are for complete acre coverage. If only a narrow band over the row is sprayed, make appropriate reductions.

Success with chemical weed control is not possible without accurate timing. Be sure to apply the materials when the *crop* and the *weeds* are in the recommended stage.

Weather affects the results. When a dry spell follows an application of most herbicides, particularly DN, Chloro IPC, and Crag-1, poor weed control is likely. Growers with irrigation available will find that ¼ to ½ inch of water applied soon after treating will almost always guarantee successful chemical weeding.

Results vary according to the kind of weeds present. Every herbicide is more effective against certain kinds than it is against others. Be sure of the identity of the weeds you are trying to control before deciding on a control program.

Asparagus

CMU[1] is a chemical showing excellent results in weeding asparagus. It kills a wider variety of weeds under more variable conditions of weather and soil than any of the chemicals tested to date. Apply about 2 pounds per acre just prior to cutting, and an additional 2 pounds immediately following cutting. It is usually applied after harrowing. The spray solution must be agitated vigorously to prevent the chemical from settling.

CMU is not a good grass killer. Where quack grass or other grasses are a problem, Dalapon[2] at 10 pounds to the acre applied early in the season, preferably before cutting, has given good control. An annual application for several years may be needed to eliminate heavy infestations.

Beans

Snap beans, lima beans, and dry beans can be partially weeded by pre-emergence sprays (spray applied before the beans break through the soil) of water-soluble dinitros.[3] Dinitros are particularly effective in bean fields that have many annual weeds, such as mustard, pig weed, ragweed, and the like.

Apply dinitro at the rate of 3 pounds of active ingredient to an acre just before the beans come up or when the first emerging beans begin to break through the soil. Some growers prefer to treat at time of planting. They mount a small sprayer on the planter with the nozzle directly over each row. The spray is restricted to a narrow band 8 to 12 inches wide. When treating at planting time the rate of DN per acre sprayed must be increased to 4½ pounds to the acre. However, since the spray is restricted, costs actually go down. For example, if an 11 inch swath is sprayed, and beans are in 32 inch rows, only 1/3 of the area is treated. Therefore, only 1/3 of the 4½ pounds (1½ pounds) is put on an acre of beans.

In average seasons there is no appreciable difference in control of annual weeds between spraying at emergence and spraying at planting provided appropriate rate adjustments are made. However, under dry soil conditions an application at emergence gives better weed control.

The approximate cost of materials is from $5 to $6 an acre for at-emergence sprays at 3 pounds to the acre. With beans in 32-inch rows, an 11-inch strip of spray over the row at 4½ pounds an acre would cost $2.50 to $3.00.

[1]Sold under the trade name "Karmex W"
[2]Sold under the trade name "Dowapon"
[3]Sold as "P.E." and "Premerge"

Beets

Many of the weeds common to beet fields can be controlled with concentrated salt sprays. Lamb's quarters or smooth-leaved pigweed, however, is a notable exception. It resists not only salt, but also most of the chemicals that are safe on beets. This situation arises primarily because lamb's quarters and beets are close relatives botanically speaking. Consequently, there is no really satisfactory chemical yet available for widespread use on all important weed pests of beets.

Where lamb's quarters is particularly severe, pre-emergence sprays are suggested. Stoddard Solvent (carrot spray oil) at the rate of 75 to 80 gallons an acre one day prior to beet emergence kills most common annual weeds including lamb's quarters. It does not kill ragweed. Where this latter weed is a pest, use heavier oil such as Esso 180 or HAN 132 or Socony Agronyl A at 30 gallons an acre 2 days before beet emergence. Pre-emergence oil sprays to be effective depend on emergence of the weeds before the crop is showing. In some instances growers pre-fit their soil a few days before seeding. If hard rains do not intervene between fitting and seeding, this practice insures earlier weed come-up and success of the oil spray treatment.

Salt sprays can be used if the pre-emergence oil spray was not feasible, or if it did not kill all the weeds. To make the solution, dissolve 200 pounds of ordinary stock salt in 100 gallons of water. If extra nitrogen is needed to fertilize the beets, dissolve 120 pounds of nitrate of soda plus 160 pounds of salt in 100 gallons of water. This combination of chemicals is more concentrated than salt alone and consequently under some conditions is somewhat more effective.

Apply the salt or combination solution at the rate of 200 gallons an acre of land covered. Small beets are seriously damaged by this spray. Delay treating until most plants have 3 to 5 "true" leaves. Sprayed beets will wilt but soon recover. Salt sprays are much more effective on small weeds. When used as a follow-up to a pre-emergence oil spray, they are usually much more satisfactory, because the beets will have fairly good sized leaves before the newer weeds are large enough to resist the salt treatment.

In recent years there has been a fairly wide trial use of CMU[4] for beets at rates of 0.4 pound per acre. Several cases of severe crop damage have been reported. Part of the injury was due to insufficient agitation in the sprayer tank to maintain the heavy chemical in suspension. The most serious part of the trouble is correlated with soil. On fields low in organic matter, much more damage from CMU was encountered than on those fairly high in organic content. Generally, beets were less damaged in the lower parts of a field than on the higher ridges and knolls.

[4]Sold under the trade name "Karmex W"

Chemicals or flaming help control weeds in celery seed beds.

Most sandy, gravelly soils are lower in organic matter and consequently less safe for use of CMU than are the silt and clay soils. More research is needed to establish the specific amounts of CMU to add on soils of different organic contents. Because crop response varies according to soil conditions, it is recommended that use of CMU be *limited to a small trial scale.*

Where annual grasses are likely to be a serious problem TCA can be used as a pre-emergence spray at the rate of 8-12 pounds an acre. TCA is not effective against the pigweeds. Because this chemical is extremely corrosive, the sprayer should be thoroughly flushed with clean water both inside and out as soon as the day's spraying is completed.

The approximate cost of carrot oil is $15 to $20; heavier oils $7 to $9; and salt is $6 an acre. TCA costs 50c to 60c per pound. Banding the spray on an 8- or 12-inch strip over the row reduces the material cost by about ½ or 2/3 if the beets are in 24-inch rows.

Cabbage and Related Crops

No satisfactory selective weed killers are known for crops in the cabbage family. Certain herbicides such as Chloro-IPC are relatively safe on these crops, but since important weeds like lamb's-quarters will not be controlled, the chemical cannot be recommended for most areas in New York.

Carrots, Parsnips, Parsley, Heimischa, Dill, Fennel, and Celery

Carrots, parsnips, parsley, heimischa, dill, fennel, and celery are relatively tolerant to certain oils that kill most common weeds. The best material is Stoddard Solvent or dry-cleaning fluid. This may be

purchased through most gasoline and oil companies. The oil is sprayed undiluted on the crop in the field, and kills most annual weeds except henbit, galinsoga and ragweed.

Spray the crop after it comes up with from 75 to 100 gallons an acre of Stoddard Solvent. Best weed kill results from spraying weeds less than ½ inch tall. Not all of the crops are equally tolerant of the oil. You may spray carrots any time until the roots are as thick as a lead pencil. Later applications may result in crop damage or an oily flavor of the product. Celery becomes less tolerant after the seedlings have developed two "true" leaves. Spray only in the seedbed, or a week or two following transplanting. Well-established field celery must not be sprayed except with nozzles directed at the base of the plants because of the danger of severe heart damage. Most of the other crops listed are slightly less tolerant to the oil than are carrots. Therefore, keep the material off of the plant leaves as much as possible.

Do not spray during very hot dry windy days because the crop may be damaged. Also the rapid evaporation of the oil may result in poor weed control. Higher rates of application are required under such conditions.

Do not allow oil to stand for several hours in the sprayer if it has been used for fungicides and insecticides. Minute quantities of the previous material may dissolve in the Stoddard Solvent and render it extremely toxic to the crop.

The approximate cost of materials is from $15 to $20 to the acre.

Peas

The water soluble dinitro[5] products have given excellent weed control with a minimum of damage to peas or to the hay seedings when present. The potency of dinitro is influenced by temperature. Spraying should be limited to periods when the anticipated *mid-day temperatures* are between 60° and 85°F. Treating when temperatures remain cooler may result in little or no weed kill, whereas higher temperatures may result in crop damage. Formulations of water-soluble dinitro contain 3 pounds of active ingredient per gallon of concentrate. Apply about 2 pints of concentrate at 80°F, 3 pints at 70°F, and 4 pints at 60°F, in 25 to 50 gallons of water an acre. The peas should be 4 to 8 inches tall. A dry, sunny day is best for good weed kill and little pea damage. The sprayer should be operated at less than 100 pounds pressure and with a nozzle that delivers a relatively coarse spray rather than a fine, foggy mist.

When using dinitro, not only temperature, but also humidity and rainfall must be considered. During dry periods when weeds are growing slowly, or not at all, they are more difficult to kill. Peas also are

[5]Sold as "Premerge" and "P.E."

somewhat more resistant to DN when they are growing slowly due to dry weather. Under these conditions increase the rate of DN by about 1 pint over the amounts suggested above for the various temperature ranges.

When peas are not being used as a nurse-crop for hay seedings, the same dinitro products can also be used as a soil spray just prior to crop emergence. The rate must be at least 1 gallon (3 pounds) of concentrate per acre. The advantages of this type of treatment are that it spreads the period over which spraying can be done and in addition there is no danger of crop injury or weed control failure due to unpredictable temperature changes following treating.

Recent experiments indicate that DN sprays may be safe and effective when applied by airplane. However, it is difficult to be sure that exact amounts are being applied by this method. Use the rates of DN listed for ground equipment, but the water can be as low as 5 gallons to the acre. *Only use air application as a trial method.*

Cost of water soluble dinitro concentrates is between $5 and $6 a gallon.

Onions[6]

One of the major weed pests of onions is purslane or pussley. Chloro-IPC is a very effective herbicide for the control of this weed and the following suggestions are primarily for its control:

1. Apply Chloro-IPC at 4 pounds to the acre just prior to onion emergence.

2. A second application of Chloro-IPC at 4 pounds to the acre should be made after the onion tops are tall enough to permit directing the spray across the row so as to cover the soil between the plants but without hitting the onion tops.

3. About July 1, before the onion tops have fallen over enough to prohibit directional sprays, apply Chloro-IPC as is suggested in 2.

For farms with weeds such as redroot and annual grasses, somewhat heavier rates may be advisable. In this case it is desirable to make the application in bands so as to reduce the total amount of Chloro-IPC used to the acre. *Caution:* potatoes, lettuce and other muck crops are less tolerant of Chloro-IPC residues than are onions. Since there is insufficient data on persistence of Chloro-IPC in muck soils, growers are advised not to increase their application rates without considering the possible ill effects this increased rate might bring about in succeeding growing seasons. Furthermore, fall cover crops are almost impossible to establish if heavy Chloro-IPC applications have been made.

There is considerable evidence that on many farms where Chloro-IPC has been used to control purslane, problems with grass, especially

[6]Prepared by G. J. Raleigh

To control mustard, a dinitro spray was applied when the peas were 6 inches tall.

crab grass, tended to increase because growers did relatively little hand or mechanical weeding. If this situation persists, crab grass and related plants will eventually cause as much trouble as pussley previously did. Additional research for grass control in onions is needed.

For those growers who have an early weed problem, especially where lamb's quarters is the most important weed, pre-emergence treatment of the land with special grade cyanamid at the rate of 75 pounds to the acre is suggested. The cyanamid should be applied before any of the onions have broken through the ground. It is very important that the cyanamid be applied evenly. Uneven distribution causes poor weed control in the areas with too little cyanamid and injury to the onions in areas getting more than 75 pounds to the acre.

Where weeds other than pussley or purslane are the major problem, some growers are using herbicides such as potassium cyanate, Herbisan, and the like. Follow the manufacturer's directions for use of these materials.

In two trials last year, CDAA[7] applied as a pre-emergence spray controlled several kinds of weeds better than any material tested to date with very little injury to the onions. Growers with weeds not well controlled by Chloro-IPC may wish to use this material *on a small trial basis* as a pre-emergence spray at the rate of six pounds to the acre. It is suggested that *trials be made early* so that fields may be disked deeply and replanted if severe injury should occur.

[7]Sold as "Randox" by Monsanto Chemical Company.

Table 1. Response of weeds to chemicals

	2,4-D	CIPC	DN	Sesone (Crag-1)	Stoddard Solvent	Alanap 3	CMU
Ragweed	S	R	S	S	R	S	S
Red Root	S	S	S	S	S	S	S
Lamb's Quarters	S	R	S	S	S	S	S
Purslane	S	S	S	S	S	S	S
Crabgrass	P	P	P	P	S	S	P
Barnyard grass	P	R	P	P	S	S	P
Chickweed	S	S	S	S	S	S	S
Henbit	S	R	S	S	S	-	S
Lady's Thumb Smartweed	R	S	S	P	S	S	S
Foxtail	P	P	P	P	S	S	P
Galinsoga	S	R	S	S	R	S	S
Yellow Rocket	R	R	P	R	S	-	-
Mustard	S	R	S	S	S	S	S
Nutgrass	R	R	R	R	R	R	R
Horsenettle	R	R	R	R	R	R	R

S = Susceptible and easily controlled by the chemical
R = Resistant and not usually controlled by the chemical
P = Partially controlled by high rates and/or careful timing
· = Insufficient information

Potatoes[8]

In Upstate New York

Chemical control of annual broadleaved weeds in potatoes in Upstate New York is practical. The Green Mountain, Sebago, Houma, and Russet Rural varieties have been successfully grown without cultivation or hilling. Cultivation or hilling may, however, be done at any time if necessary to prevent excessive greening. Varieties such as Katahdin, with shallow-set tubers, need to be hilled. Where annual grass is no problem and where perennial weeds, such as quackgrass, nutgrass, and horse nettle, are not serious, Dinitro sprays are suggested for mineral soils in Upstate New York.

Apply 3 pounds (1 gallon) of water soluble Dinitro[9] in 50 gallons of water before the potatoes come up, which is about 2 weeks after planting. This gives the weed seeds time to germinate. The small weeds are killed and, with no further stirring of the soil, few additional weeds come up during the remainder of the season. Late germinating grasses

[8]Prepared by Ora Smith.
[9]Sold as "Premerge" and "P.E."

redroot pigweed (seedling)

lambsquarters (smooth pigweed)

ragweed (seedling)

galinsoga

henbit

purslane

Color photographs by Raymond Sheldrake.

redroot pigweed

foxtail

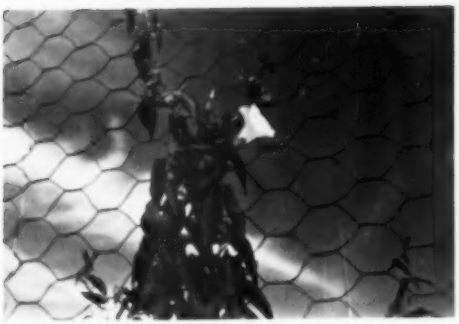
chickweed

nutgrass

ladysthumb (smartweed)

horsenettle

crabgrass



wild morning glory

mustard

yellow rocket

are not controlled. Normal cultivation may be started whenever the grower thinks it is needed for weed control or protection of tubers from light.

A regular potato sprayer may be used. Good ground coverage is essential. As soon as weed spraying is completed, wash out the equipment once or twice with clean water. This will prevent damage when spraying for insect or disease control.

On Long Island

Chemical weed control of potatoes grown on Long Island has been less satisfactory than in Upstate. Fields cultivated in the usual way have often out-yielded those treated only with chemicals. Late cultivation of chemically weeded fields increases yield, but not so much as normal cultivation. If you wish to try chemical weed control of potatoes on Long Island the treatment as listed for Upstate is suggested.

Spinach and Lettuce

At present there is no satisfactory selective weed killer for use in spinach or lettuce fields where lamb's quarters is a major pest. Where chickweed is a problem, usually on the late fall or over-wintered crops, apply Chloro-IPC at the rate of 2 pounds an acre applied just before the crop comes up. Chloro-IPC kills weeds more effectively and is more likely to injure crops at lower temperatures. If temperatures are below 50° F, use only 1 pound of Chloro-IPC, or where available apply ordinary IPC instead of the Chloro type. In cool weather 3 or 4 pounds of this material is safer than a 1 pound rate of the Chloro-IPC.

On muck soils CMU (Karmex W) at 1 pound to the acre at planting has given good control of most weeds.

Sweet Corn

2,4-D has been used with success for sweet corn. Its greatest value is in areas where broadleaved weeds predominate and where grasses are not important.

It is recommended that growers apply ½ pound of 2,4-D acid equivalent (page 20) an acre when the corn is emerging from the ground or any time until it is from 3 to 4 inches high.

When summer grasses are troublesome, sprays before the corn emerges may be of value. It is best, however, to spray no sooner than a day or two before the corn emerges. An application of 2,4-D immediately following planting often gives poorer weed control and if followed by heavy rains, may injure the corn. On light soils this injury is very likely to occur. In addition, sprays at planting require more chemical. Not more than 1 pound of 2,4-D should ever be used on sweet corn, however, due to danger of damage.

Sweet corn that has passed the 4- to 6-inch stage appears to be more sensitive to 2,4-D than when younger. Even recommended dosages

may cause the leaves to roll, the brace roots to misshapen, and the plants to become brittle and to bend. If 2,4-D is used on corn after it has passed this height, apply no more than ¼ pound of 2,4-D acid equivalent an acre. This low rate will stunt most weeds and will minimize the possibility of crop injury. These recommended rates refer to complete coverage of a field. If only crop rows are to be sprayed, calculate the appropriate reductions in rates.

Seldom does a 2,4-D spray eliminate the need for all cultivation on most New York soils. Usually machinery is needed to control grasses or to loosen soils packed by planting equipment or by heavy rains.

When to Spray Sweet Corn

From Come-up To 3 to 4 inches

Sweet corn varieties react differently to 2,4-D. In general, most of them are more sensitive to this material than are field-corn varieties. If corn is sprayed as recommended, however, there is little difference between varieties.

Wait from 10 to 14 days following a 2,4-D application before cultivating. This material may cause the corn to become brittle just after spraying, and early cultivation might cause some of the plants to break off. Also this period allows the 2,4-D to exercise its residual effect. Stirring of the soil immediately following spraying would limit its effectiveness by turning under the material and bringing up new weed seeds.

The approximate cost for 2,4-D is from $1 to $2 an acre.

Since 2,4-D may injure sweet corn under conditions of light soil and heavy rainfall, and because this chemical is hazardous to nearby vege-

Left: Here ¾ pound of 2,4-D acid equivalent was applied when the corn was 2 inches high. Note the mustard in the unsprayed area.

Right: The farmer who sprayed this corn with 2,4-D skipped a row. This field was sprayed with ½ pound of 2,4-D acid equivalent in 20 gallons of water.

table, fruit and ornamental crops, and in addition seriously contaminates sprayers, there is need for an alternative chemical.

The water soluble dinitros[10] eliminate all of the above problems inherent in 2,4-D. Their use is suggested wherever 2,4-D constitutes a hazard. Dinitros have the disadvantage, however, of requiring 3 to 4½ pounds (1 to 1½ gallons of concentrate) to an acre, unless only a band over the row is sprayed. Consequently, the cost is raised to $5 to $7.50 an acre for materials. Dilute in at least 25 gallons of water and apply before the corn has emerged. Use only 1½ pounds (2 quarts) of concentrate after the corn is showing because leaf scorch is often serious when treated at this time with higher rates. Some prefer to apply dinitro at the rate of 4½ to 6 pounds an acre at planting time. By banding only a strip over the rows, costs can be greatly reduced.

Tomatoes

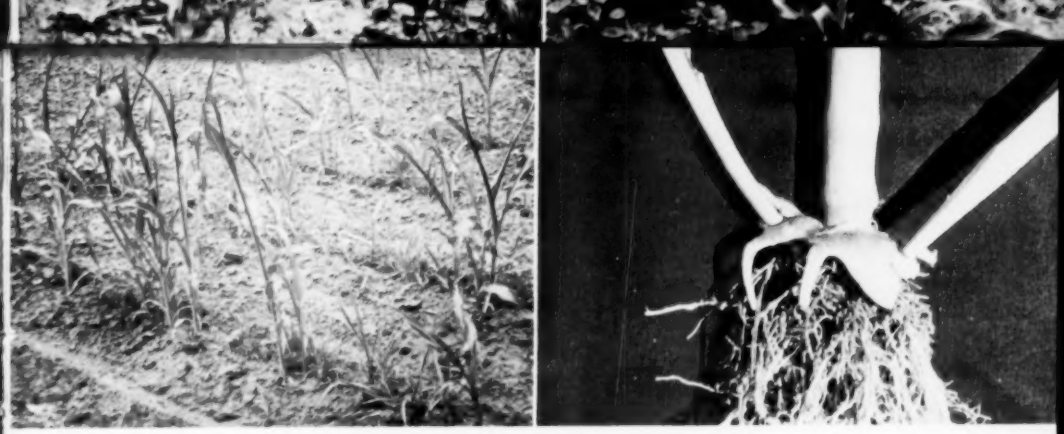
Although progress is being made in finding a selective herbicide for tomatoes, at this time there is no chemical that is sufficiently safe under all conditions to permit an unqualified recommendation. One of the best materials tested to date is "Natrin"[11]. It should be tried on *only a limited scale*, certainly on not more than 10 per cent of the acreage of any one grower.

Apply Natrin as an over-all spray at the rate of 3 pounds on sandy soils and 4 pounds on heavier soils. Natrin is only effective against weed roots as they emerge from the seed. It will not kill weeds that have fully sprouted, even if they are not yet showing above ground. Therefore, sprays must be made immediately following thorough cultivation, plus hand weeding if needed. Since thorough stirring of the entire soil surface is impossible when the plants have obtained considerable size, it is recommended that fields be treated early in the season. However, tomatoes are apt to be damaged by Natrin if the sprays are made immediately after field setting. Delay spraying until the plants have started vigorous growth following transplanting; usually about 2 weeks. Additional cultivation following spraying may be necessary if the soil has been packed by heavy rains, or if the spray has failed to control all weeds that existed prior to spraying.

Plants that are held for some length of time following pulling, or are otherwise checked in their early development, should not be treated because they are likely to have a shallow, restricted root system unduly susceptible to Natrin.

[10] "Premerge" and "P.E." are trade names.

[11] Trade name for 2,4,5-trichlorophenoxyethyl sulfate.



Left: This field received three times the recommended rate and was a total loss.

Right: The abnormal brace roots on this corn was caused by 2,4-D. This condition is not necessarily accompanied by lower yields.

Vine Crops

Muskmelons, Watermelons, Cucumbers

Alanap-3[12] is recommended for cucumbers, muskmelons, and watermelons. Since it is likely to damage squashes and pumpkins, Alanap-3 is not recommended on these crops.

Apply Alanap-3 before the crop has emerged. Use 3 to 4 pounds to an acre of land actually sprayed. Use the lower rate on sandy soils, the higher on heavy clay soils. If only a band over the crop row is covered, reduce the amount of Alanap proportionately. If spraying is done when the soil surface is dry, poor results are obtained unless rain occurs or irrigation is supplied within a day or two. *Do not apply more than one application to any given crop.*

Alanap-3 is very difficult to clean from sprayers. Use the technique recommended for 2,4-D (page 22).

2,4-D and Vegetables: *A Warning*

2,4-D has limited use for vegetable growers. It is injurious to most vegetables, flowers, shrubs, and other crop plants. Sweet corn and asparagus are the only vegetables that can be directly weeded with this chemical. It may be used, however, to control other weeds not in cultivated vegetable fields. For example, it may be used with 2,4,5-T to kill weeds and brush in hedgerows and pastures or those bordering on crop fields.

Never store containers of 2,4-D in the greenhouse headhouse or in work rooms or sheds adjacent to growing plants.

[12]Alanap-1 was changed in 1956 to Alanap-3, which is a water soluble liquid concentrate rather than a wettable powder.

WEED CONTROL CHART

Vegetable	Chemical	Preferred time of application	Pounds per acre sprayed[1]	Weeds not usually controlled[2]	Approximate cost of materials per acre[3]
Asparagus	*CMU	Before and after cutting season	1½-2 each application		$6 - $10.00
Beans	*Dinitros	At planting Pre-emergence	4½ 3	Late weeds	$5 - $6.00
	TCA	Pre-emergence	8 to 12	Lamb's quarters	$6 - $8.00
Beets	*Sodium Chloride (salt)	After beets have 3 to 5 "true" leaves	400 lbs. in 200 gal. water	Purslane, Lamb's quarters	$6.00
Carrots, parsley, parsnip, dill and fennel	*Stoddard Solvent	When weeds are small; carrots no larger than pencil	75 to 100 gal.	Ragweed	$15 - $20.00
Celery	*Stoddard Solvent	Seed beds	75 to 100 gal.	Ragweed	$15 - $20.00
Onions (muck)	Special grade Cyanamid	Not later than 2 days before come-up	75	Barnyard grass	$2.50 - $3.50
	Potassium Cyanate	Not before onions are three weeks old	1 or 2% solu.	Weeds taller than 1 to 2 inches	$5 - $10.00
	*Chloro-IPC	Pre- and post-emergence	2-3 treatments 4 lbs. each	Effective primarily against purslane	$30 - $40.00
Potatoes	*Dinitros	Pre-emergence	3 in 50 gal. water	Late germinating grasses	$5 - $6.00

Peas—no seeding Peas—seeding	*Dinitros	Pre-emergence or Post-emergence	3 to 4½ 1 to 1½	Grasses	$5 - $8.00
	*Dinitros	Post-emergence	1 to 1½	Grasses	$2 - $4.00
Spinach and Lettuce	*CMU	Pre-emergence (on muck)	1 to 1½	Lamb's quarters	$3 - $5.00
	*IPC	Pre-emergence in cold weather	4 (8 on muck)	Effective primarily against chickweed and purslane	$7 - $15.00
	*Chloro-IPC	Pre-emergence in warm weather	2 (4 on muck)		
Sweet Corn	Dinitros	Pre-emergence	4½ to 6	Late weeds	$7.50 - $10.00
	*2,4-D	At emergence (up to 3 to 4 inches in height)	½	Most grasses	$1 - $2.00
Tomatoes	Natrin (Trial basis only)	Established plants immediately after cultivation	3 to 4		$10 - $12.00
Cucumbers Watermelons Muskmelons	*Alanap-3	Pre-emergence	2 on light soil 4 on heavy soil		$6 - $12.00
Squash or Pumpkins	*Dinitros	At planting	3		$5 - $8.00

[1]Based on coverage of all the soil. Banding the spray over the crop row reduces the cost because the amount of chemical per crop acre is reduced proportionately.

[2]In addition to those weeds specifically listed, no perennials are controlled.

*Preferred treatment.

Used at normal dosages, 2,4-D is not toxic to humans or to farm animals. *Because, however, of its effect on sensitive crops be careful to prevent the material from drifting.*

2,4-D contaminates sprayers. If you must use the same sprayer for 2,4-D and other materials, be sure to follow the instructions on page 22 for cleaning out the 2,4-D residues.

Pure 2,4-D acid is not soluble in water. To facilitate its use by farmers, the acid is usually changed into salt or ester forms which may be mixed with water. Thus, most 2,4-D packages are labelled *sodium salt, amine salt,* or *ester.* Since each of these contain various quantities of the pure 2,4-D acid, it is necessary to speak in terms of the quantity of acid, or the pounds of 2,4-D acid equivalent. Thus, if you purchase a gallon of liquid containing 4 pounds of 2,4-D acid equivalent, use 1 pint of the material if you wish to apply ½ pound of 2,4-D to an acre.

Some esters of 2,4-D give off fumes that are harmful to plants. Because of this volatility, extra caution must be used in handling this form, particularly in its concentrated state. In general, it is safer to use the amine or sodium-salt forms when susceptible plants are in the same or adjacent fields.

Application Equipment[13]

Sprayer construction

Weed sprayers of various makes and styles are now readily available from farm equipment dealers. Because of the variation in rates of application for different chemicals, one must carefully consider size and type of tank, pump pressures and capacity, and size of boom. Materials and methods of construction as well as type of liquid agitation, location of boom and ease of mounting are also important.

Some of the spray materials that are used for weed control are corrosive. Therefore, it is best to select a tank of stainless steel. Though stainless steel tanks cost more, they last much longer and are trouble free. Galvanized steel or aluminum tanks are preferable to bare steel tanks. Wood is not recommended as it is impossible to remove the chemicals completely from the wood. Be sure the tank has a large opening at the top so it can be cleaned easily and the agitator can be reached for repairs. A spill proof cover should also be provided. The tank capacity needed is partially determined by the gallons of spray applied per acre, and the number of acres sprayed. For large volume spraying a "nurse" wagon increases the efficiency of operation.

Some sort of agitation or mixing in the spray tank is required. Mechanical agitation is a "must" for most wettable powder type chemicals. Hydraulic agitation is sufficient for other types of liquid formulations.

[13]Prepared by W. W. Gunkel, Agricultural Engineering.

If hydraulic agitation is used, the agitator connection should be on the pressure side rather than the by-pass side of the regulator. Regular commercial jet agitators are available for hydraulic agitation.

Diaphragm, roller-vane, plunger or piston type pumps are suitable for herbicide sprays. Centrifugal pumps can also be used but are limited to low pressure application. Wettable powder type sprays can be applied successfully with a diaphragm, piston or plunger type pump. A diaphragm pump should not be used at pressures exceeding 100 pounds per square inch.

The size of pump required depends upon: rate of application, width of spray swath and rate of travel. To allow for leakage, wear, and hydraulic agitation, additional capacity is required.

$$\text{Approximate pump capacity in gallons per minute} = \frac{\text{Gallons per acre} \times \text{Miles per hour} \times \text{Boom width feet}}{500} + (3 \text{ to } 4)$$

A pump capacity of at least 10 gallons per minute would be needed for an average size sprayer applying larger volumes (60 to 100 gallons per acre), but a capacity of 6 gallons per minute is adequate for this same size sprayer applying 5 to 30 gallons per acre.

The pump pressure can be regulated with a spring loaded relief valve or a regular unloading type pressure controller. If the pump has a built-in spring relief valve, this valve can be used for regulating pressure. A separate unloading type pressure controller is more satisfactory as it saves wear on the pump when the boom is shut off.

Use a quick acting shut-off valve in the pressure line as close to the boom as possible. The valve should be mounted so that the operator can control it from the tractor seat.

Strain all the materials that go into the spray tank. A screen on the end of the suction line will keep dirt particles out of the pump. These dirt particles are very abrasive and cause the pump to wear rapidly. There should also be a screen in the discharge line between the pressure regulator and boom. Suggested screen size for these locations are: tank screen—50 mesh, suction line screen—50 mesh, discharge line screen—100 mesh. Felt or cloth screens do not work satisfactorily with wettable powders.

A good grade of synthetic spray hose should be used between the spray tank, pump and boom. Natural rubber deteriorates when used with many of the spray materials and is not satisfactory.

Weed spraying equipment can be mounted either on the tractor or on a trailer. Tractor-mounted equipment is easier and more convenient to control if mounted in front of the operator. It is also easier to keep the boom in the proper position and to see any clogged nozzles. Trailer-mounted equipment, on the other hand, does not interfere with using the tractor for other purposes, since it is easy to detach the equipment. It also places less load on the tractor and allows the use of

a larger tank. Mist from spray is less likely to blow in the operator's face or remove paint from the tractor.

Always mount a sprayer on a tractor or trailer that can be easily adjusted to any desirable row width. A convenient vertical adjustment of the boom should also be provided. Usually a nozzle height of from 12 to 30 inches above the ground is enough, but the height varies with conditions and purpose of the application.

Since nozzle characteristics vary it is difficult to specify exactly the spacing and overlap. With the nozzles most commonly used, it is best to have about a 1/3 overlap. Spray nozzles with a 60 to 70 degree spray angle have approximately 1/3 overlap when the nozzle spacing equals the boom height. From 15 to 20 inches is a good boom height and nozzle spacing for most work. This arrangement permits the use of nozzles that do not clog easily when spraying low gallonages.

Cleaning sprayers

Residues of herbicides such as DN, CIPC, TCA, and CMU can be removed from sprayers by flushing the entire system thoroughly with clean water. Some large capacity sprayers that are designed primarily for insect and disease control sometimes have sections of pipes, pumps and tanks that cannot be readily drained and cleaned. If this type of sprayer is to be used for applying both herbicides and other pesticides, extreme care must be exercised in cleaning it.

It is very difficult to remove residues of hormone-type sprays such as 2,4-D; 2,4,5-T; and Alanap-3 from a sprayer. In fact, it is impossible to remove these residues from a wooden spray tank. Therefore, if a wooden tank is used for hormone type sprays, it should never be used for any other purpose. Whenever possible, separate equipment should be used for spraying hormone type sprays.

If you must use a hormone contaminated sprayer for other purposes, clean it as follows:

1. Rinse the sprayer two or more times with clean water.
2. Fill the spray tank lines, boom, and nozzles with a mixture of 2 pounds of sodium hydroxide (lye) and 100 gallons of water. A 1% suspension of activated charcoal in 100 gallons of water can also be used.
3. Let cleaning solution stand in tank, lines, boom and nozzles for at least 48 hours before draining. If hot water is used, 24 hours is sufficient.
4. Thoroughly rinse the sprayer two or more times with clean water.

Test your cleaning job by spraying a few sensitive plants such as tomatoes or beans. If these show no effect in a day or two, your sprayer is probably thoroughly decontaminated.

Calibrating sprayer

Successful weed control depends upon applying the right amount of chemical. The amount of water used is not important. It is, however, necessary to calibrate the sprayer (determine how much water it applies on an acre) before the spraying job is started. This calibration should be checked periodically during the season as nozzle wear tends to increase the rate of application and distort the pattern.

Special calibration jars are available from your spray equipment dealer. These jars are handy to use but a one pint container can be used successfully for this purpose.

1. Catch the discharge from one nozzle as the sprayer is being operated at the desired speed. A low cost tractor speedometer is very useful for measuring this speed.
2. Measure the distance traveled while collecting the one pint from one nozzle. Several nozzles should be checked and averaged.
3. Check the following table for the rate of application corresponding to the different distances and nozzle spacings.

Table 2. Calibration chart indicating gallons per acre

Distance in feet to collect 1 pint	Nozzle spacing — inches				
	20	18	15	12	6
40	82	91	109	136	---
50	65	73	87	110	220
60	54	60	73	91	182
70	47	52	62	80	160
80	41	45	55	69	138
90	36	40	49	62	124
100	33	36	44	55	110
110	30	33	40	50	101
120	27	30	37	46	92
130	25	28	34	42	84
140	23	26	31	39	78
150	22	24	29	36	73
160	20	22	28	34	69
180	18	20	24	31	62
200	17	18	22	28	55
220	15	16	20	25	51
240	14	15	18	23	46
260	13	14	17	21	42
280	12	13	16	20	39
300	11	12	15	18	36

For example, one may wish to apply 3 pounds of DN (1 gallon of concentrate) to an acre of beans. Spray from 1 nozzle is collected in a pint jar while driving the sprayer at the usual speed for field spraying. On measuring the distance, it is found that the sprayer traveled 120 feet to collect 1 pint. The nozzles are 18 inches apart on the boom. By using the above chart for distance and nozzle spacing, the gallonage is found to be 30. Thus by adding 1 gallon of DN concentrate (3 pounds) to the sprayer tank for every 29 gallons of water, the correct amount of herbicide will be sprayed on an acre of beans.

Caution: Sprayer speeds for calibrating must be the same as for field spraying. A change from 2 to 3 miles per hour will *reduce* the actual application by one-third. A slowing down from 3 to 2 m.p.h. will *increase* the dosage by one-half. Herbicide applications must be accurate. If too heavy, crop damage may occur and if too light, weed control will be poor.

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